BANGALORE ELECTRICITY SUPPLY COMPANY LIMITED

(Wholly owned by Government of Karnataka Undertaking)

TECHNICAL SPECIFICATIONS FOR CROSS LINKED POLYETHYLENE (XLPE) INSULATED 3 CORE 11KV CABLES

1 SCOPE:

1.1 The scope of this package, covers the design, manufacture, stage inspection at works, inspection and testing of finished cables at manufacturer's works, testing at independent test house, packing, transport and delivery to consignee's address of 6.35/11KV Three Core, aluminium conductor, XLPE insulated, screened, underground Cables as per specified construction.

1.2 Technical Requirement: Three Core 6.35/11KV grade, 90^0C rating heavy duty power cable with stranded compacted circular aluminium conductor shielded with extruded semi conducting compound, cross linked polyethylene insulated, shielded with extruded semi conducting compound and copper tape, shielded cores laid up with fillers, inner sheath of extruded PVC, Galvanized round steel wire Armour and PVC ST-2 overall sheath.

1.3 The cables should be suitable for use in solidly earthed system.

1.4 The Stranded Aluminium Conductor for different sizes of cable shall have the short circuit rating specified in this document, in schedule of requirement, schedule-I, Annexure TS-1& 2.

2.0 STANDARDS:

2.1 The 11KV UG Cables shall, in general, meet the requirements of the latest edition of the Bureau of Indian Standards, (generally referred as IS) IS 7098 (Part-2) 2011. The cables manufactured to and meeting the testing requirements of international standards, like B.S.,IEC or equivalent standards are also acceptable. The bidders shall enclose a copy of the equivalent international standard, in English Language, along with the Bid.

The extracts from IS 7098 (Part 2) are given in Annexure TS-2.

The cables and components in general shall meet the requirement Indian Standards with latest amendments or equivalent International Standards.

IS: 7098 (Part 2)	2011:	Specification for cross linked polyethylene insulated Thermoplastic sheathed cables
IS: 8130	2013 (RA 2018):	Specification for conductors for insulated Electric Cables.
IS: 3975	1999: (RA2004)	Specification for mild steel wires, strips and tapes for armouring of cables.
IS: 10810 (Part 1 to 64)	1984 to 2003:	Specification for test on cables

IS: 5831	1984:	Specification for PVC insulation and sheath of electric cables
IS: 10418	1982:	Specification for drums for electric cables
IS: 10462 (Part-I)	1983:	Fictitious calculation method for determination of dimensions of protective covering of cables: Part-I Elastomeric and thermoplastic insulated cables.
IEC 60502-Part I	2021-02	Power Cables with extruded insulation & Accessories

2.2 11KV underground cables shall be manufactured to the highest quality, best workmanship with scientific material management and quality control. The Bidder shall furnish the quality plan, giving in details the quality control procedures/management system.

The successful bidder shall give sufficient advance notice to the purchaser of not less than fifteen days to arrange for stage inspection and inspection of quality assurance programme during manufacture, at the works.

3.0 SYSTEMS DETAILS:

General Technical Particulars:

1) Nominal System Voltage (rms) (U)	-	11 kV
2) Highest System Voltage (rms) (Um)	-	12 kV
3) Phase to Earth Voltage (Uo)	-	6.35 kV
4) Number of Phases (for 3 core cables)	-	3
5) Frequency	-	50 Hz
6) Variation in frequency	-	±3%
7) Type of Earthing	-	Solidly Earthed
8) Basic impulse level (1.2/50 Micro Second Wave	-	75 kVp
9) Total relay & circuit break operating time	-	15-20 Cycles
10) One minute power frequency withstand voltage	-	28 kV

4.00 **INSTALLATION CONDITIONS**:

a) Mostly directly buried in ground, partly in RCC/Hume pipes or stoneware pipes at road crossing in case of 3 core cables.

b) If more than one circuit is laid in the same trench, then laid in flat formation for 3 core cables.

c) Metallic coverings are connected solidly to earth at both ends of the run for 3 core cables and.

d) Normal depth of laying is 900 mm to 1000 mm (from top of round to entre of cable).

e) Nature of soil – Heterogeneous, sandy.

f) Soil resistivity: variable 18 to 100 Ohm – meter

g) Soil Thermal resistivity (assumed) 120 to 150 dig. C. Cm/w.

5.0 **CLIMATIC CONDITIONS**:

The climatic conditions at Bangalore Electricity Supply Company where these 11KV Cables will be installed are as under:

1	Location	BESCOM Area
2	Altitude	1000 M above MSL
3	Max. ambient air temperature	50^0 C
4	Max. daily average air temp.	40^0 C
5	Minimum ambient air temp.	5^0 C
6	Ground temperature at depth of laying assumed	35^0 C (Max.)
7	Isoceranic level	5^0 C (Min.)
8	Avg. annual rainfall	1450 mm
9	Avg. number of rainy days	90 days
10	Climate	Tropical Moderately hot and humid
11	Soil	Normally dry. As per IS:1200 Part-I, 1974, likely hood of subsoil water at certain location at depth of burial of cables.

6.0 DESIGN CRITERIA:

6.1 The cables that are covered in these specifications are intended for use in the Karnataka Power distribution system, under the climatic conditions and installation conditions described in the technical specification.

6.2 Any technical feature, not specifically mentioned here, but is necessary, for the good performance of the product, shall be incorporated in the design. Such features shall be clearly brought out under Technical deviations schedule only in the offer made by the Bidder, giving technical reasons, and justifying the need to incorporate these features.

6.3 For continuous operation of the cables, at specified drawing, the maximum conductor temperature shall be limited to the permissible value as per the relevant standard, generally not exceeding 90^0C under normal operation and 250^0C under short-circuit conditions.

6.4 The cables in service will be subject to daily load cycles, of two peaks during day, morning peak and evening peak with reduced loading during the nights.

6.5 The materials used for sheaths shall be resistant to oils, acids and alkalies.

6.6 The cables shall be designed to withstand the thermo mechanical forces and electrical stresses during normal operation and transient conditions.

6.7 The Cables shall be designed to have a minimum useful life span of **forty years.**

6.8 Core identification: The core identification for 3 core cables shall be provided, by suitable means, like, by application of coloured stripes, or by numerals or by printing on the cores as per clause 14 of IS:7098 (Part-2) 2011.

7.0 MANUFACTURE PROCESS, CROSS LINKING OF INSULATION:

7.1 Cross linking of the insulation materials (pre compounded polyethylene) shall be conforming to IS: 7098 (Part-II)-2011.

7.2 The conductor screen shall be of extruded semi conducting compound. The insulation screen shall consist of the nonmetallic part extruded semi conducting compound with non-magnetic metallic port. The XLPE insulation and the shields for conductor and insulation shall be extended in one operation.

8.0 MATERIALS:

8.1 **CONDUCTOR:** The conductor shall be of stranded construction. The material for conductor shall consist of plain aluminium of H2 or H4 grade as per clause-4 of IS: 8130/ 2013 with purity of minimum 99.7%. and resistivity of 0.028264$\Omega mm^2/M$

The number of wires in the conductor shall be not less than the appropriate minimum number given in Table-2 of IS:8130/2013.

8.2 **INSULATION:** The insulation shall be N2 gas, dry cured, cross linked polyethylene applied by extrusion conforming to the requirements given in Table-4 of IS:7098 (Part-2) 2011.

8.3 **SCREENING:** The screening shall consist of semi conducting compound. The metallic screen for core shall consist of copper tape. The metallic screen with Armour shall be designed to carry the minimum short circuit rating for 1 second. (The design calculations shall be furnished by the bidder/manufacturer).

The semi-conducting compound shall withstand the operating temperature of the cable and shall be compatible with the insulting materials.

8.4 **FILLER AND INNER SHEATH FOR MULTI CORE CABLES:**

For Multi Core cables, the interstices at the centre shall be filled with non-hygroscopic materials.

The interstices around the laid-up cores shall be covered with PVC compound type S.T-2. This will form the inner sheath for Multi Cores Cables.

8.5 **ARMOURING FOR 3 CORE CABLES:**

The armour shall be galvanized round steel wire, complying with the requirements of IS:3975/1999 (RA-2004) and its latest amendments up to date. The Single Core Cables shall be armoured with hard drawing Aluminium round wire. A binder tape may be applied on the armour.

8.6 **OUTER SHEATH**:

The outer sheath shall consist of Poly Vinyl Chloride (PVC) compound, confirming to the requirements of Type ST-2 of IS: 5831/1984 suitable additive shall be added to give anti termite protection.

9.0 CONSTRUCTION:

The general constructional features of the cables shall be as follows:

The XLPE UG Cable is to be manufactured in continuous catenary process at controlled elevated temperature and pressure in inert atmosphere (N2 gas, Dry cure) with use of suitable materials for XLPE main insulation. The cable shall have suitable XLPE semi-conducting compound for insulation screen & conductor screen. The inner and outer semi-conducting sheaths and main polyethylene insulation between the sheaths are to be simultaneously extruded using the N_2 gas, dry cure, Triple Pressure Extrusion Process of manufacturing. The XLPE insulation and the shields for conductor and insulation shall be extended in one operation. The XLPE Cable in this specification does not have any metal sheath and the short circuit rating of the cable will depend on the conductivity and continuity of the strands of the armour wires which shall be ensured by guarding against corrosion.

9.1 **Three Core Cables**: Stranded Compacted Circular Aluminium Conductor, Conductor Screen of extruded semi conducting compound, Cross linked polyethylene insulation, shall be conforming to IS:7098 (Part-2) 2011.

9.2 Insulation screen consisting of non-metallic part of extruded semi conducting compound and the metallic part of copper tape(s).

9.3 Pressure Extruded PVC inner sheath.

9.4 Armour : Galvanized Steel round strip wire (formed wire).

9.5 Other PVC sheath with anti-termite treatment.

10.0 CONDUCTOR:

10.1.1 The conductor shall be stranded, compact, circular of aluminium wires of H2 or H4 grade plain aluminium wires of purity more than 99.7%. with resistivity of 0.028264Ω/mm

10.1.2 The conductor shall be clean, uniform in size and shape smooth and free from harmful defects.

10.1.3 Not more than two joints shall be allowed in any one of the single wire forming every complete length of conductor and no joint shall be within 300 mm of any other joint in the same layer. The joint shall be made by brazing, silver soldering or electric or gas welding.

10.1.4 No joints shall be made in the conductor after it has been stranded.

10.2 **CONDUCTOR SCREEN**: The conductor screen shall be provided over the conductor consisting of extruded non-metallic semi-conducting compound. The non-mettallic screening over conductor shall be minimum thickness 0.4mm.

10.3 **INSULATION**: The insulation shall be provided over the screened conductor with cross linked polyethylene (XLPE), applied by extrusion and shall be of high quality, Cross Linked Polyethylene (XLPE) N_2 gas, dry cure satisfying the requirement of IS:7098 (Part-2) /2011.

10.3.1 **THICKNESS OF INSULATION**: The average thickness of XLPE insulation shall not be less than the nominal value subject to the applicable tolerance as specified in Table-4 of IS: 7098 (Part-2)/ 2011.

10.3.2 The insulation shall be applied to closely fit on the conductor screen, and it shall be possible to remove it without damaging the conductor.

10.3.3 The thickness of semi conducting screen over insulation should not be included in the thickness of Insulation.

10.4 **INSULATION SCREENING:** The Insulation screen shall be applied over the Insulation.

10.4.1 The Non-Metallic part of the Insulation screen shall consist of extruded Semi conducting compound. The non-metallic screening over the insulation shall be minimum thickness of 0.3mm.

10.4.2 The metallic part of the insulation screen shall consist of non-magnetic material, consisting of copper tape or tapes, and shall be applied over the non-metallic part. The metallic tape(s) shall be designed to carry the rated short circuit current. The metallic screening plain copper tape shall be minimum thickness of **0.045mm** (±0.005mm) with overlapping of copper tape shall not less than **5%.**

10.5 **LAYING UP OF CORES:** For multi-core cables, the cores shall be laid together with a suitable right hand lay. The interstices at the centre shall be filled with a non-hygroscopic material.

10.6 **INNER-SHEATH FOR MULTI CORE CABLES:**

10.6.1 The cores shall be laid up with a suitable right hand lay and the interstices should be filled with PVC compound type ST2 conforming to IS:5831-1984 with latest amendments or equivalent International standard. The filling up of interstices shall be by pressure extrusion and this circular shape and shall bind the cores also.

10.6.2 The minimum thickness of the inner sheath shall conform to Table 5 of IS: 7098 (Part-2), 2011 or equivalent International standard.

10.6.3 The inner-sheath shall be so applied that it fits closely on the laid-up cores and it shall be possible to remove it without damage to the insulation cables.

10.7 **ARMOURING FOR 3 CORE CABLES:**

10.7.1 **Application**: The armour consisting of galvanized steel wire shall comply with the requirements of IS-3975 -1999 (RA-2004) with latest amendments and shall be applied over the inner sheath for multi core cables with coverage of minimum 90%.

10.7.2 The round strip armour wires shall be applied as closely as possible. The resistivity of armour shall not exceed 14.5 $x10^{-6}$ ohms-cm and tolerances for formed wires shall be ± 5 % of the nominal dimensions.

10.7.3 The diameter of the galvanized round steel and hard drawn aluminium wires shall conform to table-6 of IS: 7098 Part (2)-2011.

10.7.4 A binder tape may be applied on the armour.

10.7.5 The Joints in the armour wires shall be brazed/ welded with joint surface and rendered smooth. The joints shall be staggered by at least 300 mm from the nearest joint in any other armour wire in the completed cable.

10.8 **OUTER SHEATH:**

10.8.1 The outer sheath shall be of PVC confirming to the requirements of Type ST-2 of IS 5831-1984 with latest amendments with anti-termite treatment shall be extruded over the armouring for 3 core cables.

10.8.2 The colour of the outer sheath shall be black.

10.8.3 The thickness of outer sheath shall be not less than the minimum value specified in column 5 of Table 7 of IS: 7098 (Part-2) 2011 with latest amendments.

10.8.4 Carbon black content: As per IEC 60502-Part-I/2021-02, the carbon content shall be within 2-3 %.

10.8.5 The outer sheath shall withstood the Thermal stability for a period not less than 100 minutes.

10.9 IDENTIFICATION: The outer-sheath shall have the following information embossed or indented on it, the manufacturer's name or trade mark, the voltage grade, the year of manufacture and the letters "BESCOM". The identification shall repeat every 500mm along with length of the cable.

11.0 INSPECTION:

11.1 Quality Control: The Bidder shall furnish a complete and detailed quality plan for the manufacturing process of the cable. All raw materials shall conform to relevant applicable standards and tested for compliance to quality and requirement.

During the manufacturing process, at all stages, inspections shall be made to check the physical and dimensional parameters, for verification to compliance to the standards.

11.2 The Bidder shall arrange, for inspection by the purchaser during the manufacture, to verify the quality control process of the Bidder.

12.0 TYPE TESTS:

All the cables of offered sizes, shall be fully type tested as per the IS:7098 (Part-2), 2011 with up-to-date amendments or equivalent international standard at CPRI/ERDA/NABL Accredited Govt. Labs and the date of type test shall not be older than 5 years. Notwithstanding, that type test have been conducted earlier, the successful bidder shall conduct all type tests as per IS:7098 (Part-2), 2011 with up-to-date amendments or equivalent international standard at his cost, either at CPRI/ERDA/NABL Accredited Govt. Labs and materials offered for inspection. Only after approval of the test reports from the purchaser materials shall be offered for inspection.

12.1 "On receipt of the specified lots of 11kV HT UG cables from the factory at site /stores by BESCOM, a team consisting of one person from the supplier, one person from BESCOM shall select a sample of sufficient size, as per relevant IS and conduct all type tests at CPRI/ERDA only. Payment for type testing charges will be considered after the receipt of satisfactory results."

In case of failure, the entire lot will be rejected and another sample will be referred to Bureau of Indian Standards (BIS) as a complaint for assessment of quality of the manufacturer." In the mean while the supplier/Manufacturer shall have to replace the entire lot with good quality Cables.

12.2 All routine and acceptance test shall be conducted in the presence of the representatives BESCOM.

12.3 The inspecting Officers conducting inspection/acceptance tests at factory shall strictly follow and check facilities as per the check list enclosed.

12.4 The successful Bidder shall give 15 days' advance notice for inspections, and witnessing of tests by the purchaser or his representative.

12.5 The following type tests will be conducted on the cable.

1. Test on conductor
   a. Tensile test (for aluminium)
   b. Wrapping test (for aluminium)
   c. Resistance test
2. Test on armour wires
3. Physical test on XLPE insulation
   a. Tensile strength and elongation at break
   b. Ageing in air oven
   c. Degree of cross linking
   d. Hot set test
   e. Shrinkage test
   f. Water absorption test (gravimetric)
4. Test for thickness of XLPE insulation and inner and outer sheaths
5. Test on extruded semi conducting screens
   a. Test for strippability of semiconducting strippable insulation screen (when applicable)
   b. Volume resistivity
6. Physical test for outer sheath
   a. Tensile strength and elongation at break
   b. Ageing in air oven
   c. Shrinkage test
   d. Hot deformation
   e. Loss of mass in air oven
   f. Heat shock
   g. Thermal stability
   h. Carbon black content of polythene sheath
7. Thermal aging on complete cable
8. Partial discharge test

9. Bending test
10. Di-electric power factor test
    a. As a function of voltage
    b. As a function of temperature
11. Insulation resistance (Volume resistivity) test
12. Heating cycle test
13. Impulse withstand test
14. High voltage test
15. Flammability test for PVC sheathed cables

12.6 The following test shall be performed successively on the same test sample of completed cable, not less than 10 M in length between the test accessories.

a) Partial discharge test
b) Bending test followed by partial discharge test
c) Dielectric power factor as a function of voltage
d) Dielectric power factor as a function of temperature
e) Heating Cycle test, followed by dielectric power factor and function of voltage and partial discharge test.
f) Impulse withstand test
g) High voltage test.

12.7 **ACCEPTANCE TEST**:

12.7.1 The sample shall be taken and tested from each lot for ascertaining the conformity of the lot of the standard. The sampling plan for acceptance test shall be as per IS: 7098 Part (2) 2011, Annex "D".

Sl.No.	No. of Drums in a LOT	No. of drums to be taken as Sample	Permissible No. of Defectives
1	Up to 25	3	0
2	26 to 50	5	0
3	51 to 100	8	0
4	101 to 300	13	1
5	301 and above	20	1

I. The following shall constitute the acceptance test.

a) Tensile test for aluminium
b) Wrapping test for aluminium
c) Conductor resistance test
d) Test for thickness of insulation
e) Test for thickness of inner and outer sheath
f) Hot-set test for insulation
g) Tensile strength and elongation at break test for insulation and outer sheath
h) Partial discharge test (on full drum length)
i) High voltage test
j) Insulation resistance (volume resistivity) test.
k) Test for cross linking for extruded semi conducting screen.

Note: Partial discharge test shall be carried out on full drum length.

II The inspecting Officers conducting inspection/acceptance tests at factory shall strictly follow and check facilities as per the check list enclosed.

12.8 **ROUTINE TEST**:

The following shall constitute routine tests:

a) Conductor resistance test
b) Partial discharge test on full drum length
c) High voltage test
d) Resistance test for armour in accordance with IS 10810 (part-42) 17.5 of IS 7098(Part-2) 2011.

13.0 PACKING:

13.1.1 The cables, as per specified delivery lengths, shall be securely

13.1.2 Wound/packed in non-returnable, well-seasoned sturdy non-returnable wooden drums, with strong reinforcements so as to withstand rough handling during transport by Rail, Road etc., The packing should withstand storage conditions in open yards. The cable drums shall conform to IS:10418-1982 or equivalent International standard.

13.1.3 The drawing of cable drums with full detail shall be furnished, and got approved before dispatch.

13.2 **SEALING OF CABLE ENDS ON DRUMS**:

13.2.1 The Cable ends shall be sealed properly so that ingress of moisture is completely prevented.

13.2.2 The individual core endings shall be sealed effectively with water resistant compound applied over the core and provided with a heat shrinkable cap of sufficient length with adequate cushion space so that the conductor does not puncture the cap in case of movement of the core during unwinding or laying. Before sealing, the semi conducting layer on the cores may be removed for about 2 mm at each end, to facilitate checking the insulation resistance from one end, without removing the sealing cap at the other end.

13.2.3 The three cores should have a overall heat shrinkable cap with adequate end clearance, and sufficient cushioning to prevent puncturing of the overall sealing cap due to stretching of the cores. The sealing cap shall have sufficient mechanical strength and shall prevent ingress of moisture into the cable.

13.2.4 **CABLE LENGTHS**: The cables shall be supplied in continuous lengths of 250/500 m in case of 3 core cables with a tolerance of ± 5% of drum length.

13.2.5 **QUANTITY TOLERANCE**: ±5% tolerance shall be allowed on the ordered quantity.

13.2.6 **SAFE PULLING FORCE:** 30N/ Sq. mm for Conductor

14.0 MARKING:

The packed a cable drum shall carry the following information, clearly painted or stenciled.

1) The letters "BESCOM"
2) Reference to Standard and ISI Mark
3) Manufacturer's Name or trade mark
4) Type of Cable & Voltage grade
5) Number of cores
6) Nominal cores sectional area of conductor
7) Cable code
8) Length of cable on the drum
9) Direction of rotation
10) Gross weight
11) Country of Manufacture
12) Year of Manufacture
13) Purchase Order No. and Date
14) Address of consignee.

15.0 Cross sectional drawings of the cables giving dimensional details for each size of cable.

An illustrated literature on the cable giving technical information, on current ratings, cable constants, short circuit ratings, derating factors for different types of installation packing date weights and other relevant information.

General Manager El.,
QS&S, BESCOM

SCHEDULE-I

Annexure: TS-1

Schedule of requirement of 3 core armoured, 1 core armoured, 6.35/11KV (E) aluminium conductor, XLPE UG Cables

Sl. No.	Cross sectional area of conductor (Sq.mm.)	Minimum current rating (Amps) in ground	Minimum short circuit rating (KA/1 Sec)	Delivery length per drum (± 5%)
1	3C x 95 Sq.mm	190 Amps	8.9KA	500 M
2	3C x 240 Sq.mm	315 Amps	22.5KA	250 M
3	3Cx 400 Sq.mm	404 Amps	37.6KA	250 M

The approximate current ratings in column 3 are for the following standard installation conditions.

i)	Maximum conductor temperature for continuous operation	90 Deg. C.
ii)	Ambient air temperature	40 Deg. C.
iii)	Ground temperature	30 Deg. C.
iv)	Thermal resistivity of soil	0.6 to 1.0 K-m/watts
v)	Depth of laying	90 cm
vi)	Maximum conductor temperature at the end of short circuit	250 Deg. C.
vii)	Method of installation	Installed single directly buried in ground

SCHEDULE-II

Annexure: TS-2

For the information of Bidder, the important extracts from the Indian Standard IS:7098 (Part 2) 2011; Table-1 Specification for cross linked polyethylene insulated PVC sheathed cables are furnished here for their reference and to supply for the XLPE Cables called for in the bid specification

TABLE-1:- PROPERTIES OF XLPE INSULATION

Sl. No.	Property	Requirement
1	Tensile Strength	**12.5 N/Sq.mm., Minimum.**
2	Elongation at break	**200 percent, Minimum.**
3	**Ageing in air oven**: a) Treatment: Temperature Duration b) Tensile Strength Variation c) Elongation Variation	 135 ± 3 Deg. C 7 Days ± 25% Max. However minimum tensile strength shall be 12.5 N/Sq.mm ± 25% Max. However minimum elongation at break shall be 200 Percent
4	**Hot Set**: a) Treatment: 1. Temperature 2. Time under load 3. Mechanical stress b) Elongation under load c) Permanent Elongation (Set) after cooling	 200 ± 3 Deg. C 15 minutes 20 N/Sq.mm. 90 % Max. 10 % Max.
5	**Shrinkage**: a) Treatment: Temperature Duration b) Shrinkage	 130 ± 3 Deg. C 1 Hour 4% Max.
6	**Water absorption (gravimetric)**: a) Treatment: Temperature Duration a) Water absorbed	 85 ± 2 Deg. C 14 Days 1 mg/Sq.cm.(Max.)
7	**Volume resistivity**: a) At 27 Deg. C b) At 90 Deg. C	 1×10^{14} ohm-cm. Min. 1×10^{12} ohm-cm. Min.

TABLE- 2:- PROPERTIES OF EXTRUDED SEMICONDUCTING SCREEN AS PER IS 7098 –II/ 2011

Sl.No.	Property	Requirement
1	Strippability test for strippable semiconducting insulation screen	Force required to remove semiconducting screen from insulation without damaging shall be not less than 4 N or greater than 45 N before and after ageing when test as per Method of Test as per Annexure **B of IS 7098 -II/2011**
2	Resistivity test for semiconducting screen: a) Conductor screen b) Core screen	Method of Test as per Annex E 1000 ohm m, Max 500 ohm m *Max*

TABLE- 3:-

A) PROPERTIES OF THERMOPLASTIC POLYETHYLENE SHEATH {If Applicable} As Per Table 3 (Clause 9) of IS 7098-II/2011

Sl.No.	Property	Requirement
1	**Without aging** a) Tensile strength (N/mm²) b) Elongation at break	 **12.5 N/mm², *Minimum*** **300 percent, *Minimum***
2	**Ageing in air oven**: a) Treatment: { Temperature Duration b) Elongation at Break	 110 ± 2 Deg. C 7 Days **300 percent, Minimum.**
3	Carbon black content	2.5 ± 0.5 percent
4	Hot deformation test 110 ± 2 °C for 6 hrs Maximum depth of indentation	50 percent

B) REQUIREMENTS OF PVC SHEATH {TYPE OF PVC SHEATH ST-2} As Per Table-2 (Clause 4) of IS : 5831-1984

Sl. No.	Property	Requirement
1	**Without aging** a) Tensile strength (N/mm²) b) Elongation at break	 **12.5 N/mm², *Minimum*** **150 percent, *Minimum***
2	**Ageing in air oven**: b) Treatment: { Temperature Duration c) Tensile strength & variation d) Elongation at Break & variation	 100 ± 2 Deg. C 7 Days 12.5 N/mm² ±25% 150 percent, Min & ±25%
3	Carbon black content	2.5 ± 0.5 percent
4	Hot deformation test 30 ± 2 °C for 6 hrs Maximum depth of indentation	50 percent

TABLE-4:- NOMINAL THICKNESS OF INSULATION As Per Table 4 of IS 7098-II/2011

Nominal Area of Conductor in Sq.mm.	Nominal thickness of insulation (ti) in mm. 6.35/11KV – 3 Core
95	3.6
240	3.6
400	3.6

15.1.A Thickness of insulation: The average thickness of insulation shall not be less than the nominal value (ti) specified in Table-4 of IS 7098 (Part-2) of 2011.

15.1.B Tolerance on thickness of insulation: The smallest of the measured values of thickness of insulation shall not fall below the nominal value (ti) specified in Table-4 by more than 0.1 mm + 0.1 ti.

TABLE-5:- THICKNESS OF INNER SHEATH (All dimensions in mm) As per Table 5 of IS 7098-II/2011

Calculated diameter over laid up cores (ref. IS 10462 Part 1, 1983) *		Thickness of inner sheath (Min.)
Over	Up to & including	
(1)	(2)	(3)
-	25	0.3
25	35	0.4
35	45	0.5
45	55	0.6
55	-	0.7

(*) Fictitious calculation method for determination, dimensions of protective coverings of cables: Part-I Electrometric and Thermoplastic Cables.

TABLE-6:- DIMENSIONS OF ARMOUR GALVANIZED STEEL ROUND WIRES AND FORMAED WIRES

NOTE: The dimensions of Galvanized steel wires or strips shall be as specified in Table-6 of IS 7098-II/2011. **However, the tolerances for formed wires shall be ± 5 % of the nominal dimensions.**

Calculated diameter for Armour (ref. IS 10462 Part 1, 1983) *		Nominal thickness of steel strip	Nominal diameter of Round wire
Over	Upto & including		
1	2	3	4
a) For all diameter in excess of 13		0.8	Nil
-	13	-	1.40
13	25	0.8	1.60
25	40	0.8	2.00
40	55	1.4	2.50
55	70	1.4	3.15
70	-	1.4	4.00

Note: (a) and (b) indicate two methods of practice in the application of armouring.

* Fictitious calculation method for determination of dimensions of protective covering of cables: Part-I Electrometric & Thermoplastic Insulated Cables.

TABLE-7:- THICKNESS OF OUTER SHEATH (All dimensions in mm)
{As per Table 7 of IS 7098-II/2011

Calculated diameter under the outer sheath (ref. IS:10462 Part 1, 1983) *		Nominal thickness of outer sheath of Un-armoured Cables		Minimum thickness of outer sheath for Armoured Cables
Over	Up to & including	Nominal (ts)	Minimum	
1	**2**	**3**	**4**	**5**
-	15	1.8	1.24	1.24
15	25	2.0	1.40	1.40
25	35	2.2	1.56	1.56
35	40	2.4	1.72	1.72
40	45	2.6	1.88	1.88
45	50	2.8	2.04	2.04
50	55	3.0	2.20	2.20
55	60	3.2	2.36	2.36
60	65	3 .4	2.52	2.52
65	70	3.6	2.68	2.68
70	75	3.8	2.84	2.84
75	-	4.0	3.00	3.00

(*) Fictitious calculation method for determination of dimensions of protective covering of cables: Part-I Electrometric & Thermoplastic Insulated Cables.

Note: Armoured Cables: The thickness of outer sheath shall be not less than the minimum value specified in column 5 of Table-7.

Extracts from IS:7098 (Part 2), 2011, on Tests on Cables:

i) **Partial Discharge Test:** The Partial discharge magnitude at test voltage equal to 1.5Uo shall not exceed 20 pC.

ii) **Bending Test:** The diameter of test cylinder shall be (20D ±5) percent, where D is the overall diameter of the completed cable.

iii) **Dielectric Power Factor Test:**

a) "Tan delta" as a function of voltage:
The measured value of "tan delta" at Uo shall not exceed 0.004 and the increment of "tan delta" between 0.5Uo and 2Uo shall not be more than 0.002.

b) "Tan delta" as a function of temperature:
The measured value of "Tan delta" shall not exceed 0.004 at ambient temperature and 0.008 at 90 Deg. C.

iv) **Heating Cycle (As per IS: 10810 Part 49):**

After heat cycle, the sample shall be subjected to dielectric power factor as a function of voltage and partial discharge test.

v) **Impulse withstand test:**

The impulse voltage level for cables of rated voltage 6.35/11KV is 75kV and No breakdown of insulation shall occur during the test. (Ten positive & Ten Negative impulse)

vi) **High voltage test** (As a type test/Acceptance test) for 6.35/11KV rated voltage cables:

The cable shall withstand without breakdown an A.C. Voltage equal to 3Uo but not less than 17 KV (rms when applied to the sample between conductor and screen/metallic tape/armour, the voltage shall be gradually increased to the specified value and maintained for a period of 4 hours.

vii) **Armouring details :**

Sl.No	HT UG Cable Size	No. of Armour wire	Size
1	3Cx95 Sqmm,	54 GI Wires	2.5 mm Dia
2	3Cx 240 Sqmm,	55 GI Wires	3.15 mm Dia
3	3Cx 400 Sqmm,	51 GI Wires	4.00 mm Dia

Sd/-
General Manager El.,
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SCHEDULE-III

Annexure: TS-3

General Technical Particulars of 11kV Class HT UG Cable
(Please refer to Standard GTP enclosed)

11kV (6.35/11kV), 3 Core, XLPE HT UG Cables H2/H4 grade Aluminum conductor having purity of 99.7% and maximum resistivity of 0.028264 Ωmm2/m, Insulated through Dry Cure Triple Extrusion Single Head Process with high quality clean XLPE Compound (Free from micro voids, moisture content ambers and contaminations) having maximum Hot set value of 90% in-process, Metallic Screen with EC Grade Copper Tape having thickness of 0.045mm ± 0.005 mm with 5% coverage, pressure extruded virgin PVC compound inner sheath, GI Round wire armouring, number of armoured round wires as per BESCOM SR required wire diameter Tolerance of ±5% and maximum resistivity of 14.5 $x10^{-6}$ ohms-cm as per IS-3975, Extruded PVC type ST2 compound outer sheath having minimum thermal stability value of 100 minutes.

Sl.No.	Particulars	unit	HT UG Cable
1	Cables		
	a) Name of manufacturer		
	b) Place of manufacture		
2	Cable Type		A2XWY
3	Applicable **specifications** & standards voltage Grade		IS: 7098 (Part-2) /11kV
4	Suitable for effective Earth/Unearth system		
6	Permissible voltage & frequency variation for satisfactory operation		
7	**Continuous current for standard condition as per IS:**		
	a) In air (45º C)	Amps	
	b) In Ground (30º C)	Amps	
	c) In Duct	Amps	
8	**Conductor**		
a)	Material		Aluminium (H2/H4 Grade)
b)	Purity & Resistivity of Conductor@20ºC		
c)	Shape of conductor		
d)	Geometrical cross sectional area	mm²	
e)	Number of wire: (min)	No	
f)	Diameter of Wire : mm before compacting & strand Diameter	mm	
g)	Maximum DC resistance of the conductor at 20º C	Ω/KM	….....(**CR value only for reference)**
h)	h) Sampling batch for test		As per IS 7098- II/2011
9	**Conductor Screening**		
a)	Material		Extruded Cross linked Semi conducting compound
b)	Process		Dry cure Triple Extrusion Single head process
c)	Thickness (Min)	mm	
d)	Continuous working temp	deg.C	90

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e)	Max allowable temp at termination of short circuit	deg.C	250
10	**Insulation:**		
a)	Material		High Quality clean XLPE Compound (Free from Micro voids, moisture content ambers and contaminations)
b)	Thickness of Insulation (Nom)	mm	
	i) Between Cores	mm	
	ii) Between Cores & Inner Sheath		
c)	Minimum thickness of insulation at any one point	(mm)	
d)	Extrusion Type		Pressure Extruded
e)	Specific insulation resistance at 90º C	Ohm- cm	
f)	**Hot Set test:**		
	i) Elongation under load **in process**	%	90% Maximum
	ii) Maximum Permanent elongation after cooling	%	10% Maximum
	iii) Tensile Strength at break	N/mm²	
	iv) Elongation at break	%	
11	**Insulation Screening:**		
	a) Material		Extruded Cross linked semi conducting compound
	b) Min. Thickness of extruded semi conducting layer	mm	
	c) Metallic Part: (Material)		Plain copper tape
	d) Size of copper Tape	mm	
	e) Whether over lapping provided		Min 5% of Overlapping
	f) Short Circuit rating in 1 sec.	kA	
12	**Inner Sheath**		
	a) Material		PVC compound Type -ST2
	b) Extrusion Type		Pressure Extruded
	c) Thickness (Min)	mm	
	d) Nominal Dia over Inner Sheath	mm	
13	**Armouring**		
	a) Material		Hot dip Galvanized Steel
	b) Type of armouring		Round wire
	c) Nominal Dimension of Armour wire	mm	……. Dimension and ±5% of Tolerance
	d) Armour Resistivity (Max) as per IS 3975	Ohm-cm	
	Minimum Number of Armour wire		……. Numbers (Minimum) refer BESCOM SR
	e) Whether Galvanized		
	f) Mass of Zinc coating	Gms/M²	
	g) Nominal Dia over Armouring	mm	
	h) Short Circuit rating in 1 sec	kA	

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14	**Outer Sheath**		
	a) Material		Extruded PVC Compound Type ST-2
	b) Extrusion type		Extruded
	c) Min. thickness of sheath	mm	
	d) Nominal Overall diameter of cable	mm	
	e) Thermal stability test for sheath	Minutes	Minimum 100 minutes
	e) Tensile Strength at break	N/mm^2	
	g) Elongation at break	%	
15	Short circuit withstand capacity		
	a) Short Circuit withstand capacity	kA	
	b) Duration of short circuit	sec	One
16	AC resistance per core at operating temperature	ohm/km	
17	Reactance Ohm/Km	ohm/km	
18	Capacitance per core	µF/km	
19	Allowable maximum conductor temperature when carrying current		
20	Insulation resistance at 27º C	ohm-cm	
21	Loss tangent		
22	Maximum cable charging current at normal operating volt	A/km	
	Additional data		
23	Core identification		Application of coloured stripes Red, Yellow & Blue
24	Standard Packing Length and Tolerance	Mtrs	
25	Scheme of identification of the cable		Manufacturer's name or trade mark, voltage grade, year of manufacture, Project Name/W.O. No. and the letters "BESCOM". The identification shall repeat every 300/350 mm along with length of the cable.

Seal and Signature of the Supplier